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NOTES AND QUERIES.

ON THE PERIOD INTERVENING BETWEEN THE DATE OF DEATH AND PAYMENT OF SUM ASSURED.

THE usual system of calculating premiums is founded on the supposition that the sum assured is payable in each case at the end of the year of death, or at that period at which the next renewal premium would have become due. In practice, however, in place of adapting this system to every case, an average period of six months after death was formerly adopted and is still current in some Offices, while others have reduced the term to three months, and some to no more than as many weeks. It thus becomes a matter of some little importance to determine the premium fairly chargeable for a sum assured to be due at the instant of death, and to bear interest until the date of actual payment.

Historically speaking, the subject strictly begins with De Moivre, who was the first to teach us how to assess the value of a reversion. Simpson, who was a rival, and Dodson, who was a disciple, were nevertheless somewhat indiscriminate copiers of De Moivre, for they appear to have imagined that he assigned $1-i\text{A}$ as the present value of £1 payable at the *end* of the year of death, and they accordingly also adopted that value. There are reasons however for imagining, that in one case at least this celebrated analyst fell into no such error, but correctly assigned $1-i\text{A}$ as the present value of £1 due at the *beginning* of the year of death, and bearing interest until actual payment ensued. This conclusion may be deduced from the method he has adopted in solving the following problem (XVI.), as it occurs in his *Treatise on Annuities*:—

"A borrows a certain sum of money, and gives security that it shall be repaid at his decease, with the interests. To fix the sum which is then to be paid—let the sum borrowed be s; the life of the borrower, M years' purchase; d the interest of £1: then the sum to be paid at A's decease will be

$$\frac{s}{1-d\text{M}}."$$

From this it is obvious that $1-d\text{M}$, or in modern notation $1-i\text{A}$, was considered the present value of £1 at last of the 'interests,' or the beginning of the year of death, or of £1 at actual death of A, with such interest as might have already accrued for the current months and days. Now as half a year's interest is the most probable increment from such a source, $\dfrac{1-i\text{A}}{1+\frac{i}{2}}$ will be the present value of £1 without interest at the instant of death, and $\dfrac{1-i\text{A}}{1+i}$ that of £1 without interest at the end of the year of death; consequently the ratio of the latter to the former is as $1:\dfrac{1+i}{1+\frac{1}{2}}$.

Mr. Sang, in his tables, does not explain by what formula he worked as to the claim at the instant of death; but if the ordinary Carlisle premiums at 3 per cent. be simply multiplied by $\dfrac{1+{\cdot}03}{1+{\cdot}015}=1{\cdot}0147$, &c., as prompted by the preceding expression, the values will be found concurrent with his own.

Some familiar correspondence which has recently taken place between Professor De Morgan and one of the Vice-Presidents of the Institute

(Mr. Hardy), at the suggestion of the former—and which correspondence the present writer has had the opportunity of seeing—illustrates the value of a reversion in so simple and explicit a manner as to have led to the preceding remarks, and title of the present paper. The Professor virtually says—Suppose £1 is producing i per annum in the 100 i per cents. for A's benefit, and at the end of the year of A's death B or his executors is to take the £1 and the interest i then due; now if A and B desire to reduce their claims upon the £1 into present values, A should clearly claim $i\mathrm{A}$ in place of his annual interest, and B the remainder, or $1-i\mathrm{A}$, in place of the $1+i$ at the end of year of A's death; so that $\frac{1-i\mathrm{A}}{1+i}$ becomes the ordinary and well known value of the reversion.[*]

La Place has taken a somewhat similar view (modern notation is also inserted):—

"L'analyse précédente sert pareillement à determiner la rente viagère que l'on doit faire à une établissement, pour assurer à ses héritiers un capital après sa mort. Le capital équivalant à la rente viagère $h(=1)$, faite à une personne de l'âge A, est, par ce qui précède, $h.\mathrm{S}.\frac{p^x.y_x}{y_0}(=\mathrm{A})$, le signe S comprenant tous les termes inclusivement depuis $x=1$ jusqu'à la limite de la vie de la personne. Nommons $hq(=\mathrm{A})$ cette intégrale, et imaginons que l'établissement recoive de cette personne la rente $h(=1)$, et lui donne en échange le capital à intérêt perpétuel sur l'établissement lui-même; l'intérêt annuel de l'unité etant r ou $\frac{1-p}{p}(=i)$. Il est clair que l'établissement doit rendre le capital $hq(=\mathrm{A})$, aux héritiers de la personne. Mais elle a fait pendant sa vie la rente $h(=1)$ à l'établissement, et elle en a reçu la rente $\frac{hq.(1-p)}{p}(=i\mathrm{A})$; la rente qu'elle a faite réellement est donc

$$h\left[1-\frac{q.(1-p)}{p}\right](=1-i\mathrm{A});$$

c'est donc ce qu'elle doit donner annuellement à l'établissement, pour assurer à ses héritiers le capital $hq(=\mathrm{A})$."[†] (Vol. vii. p. 471.)

With respect then to the actual payment of claims, the simplest and most correct plan, and the one which the public would perhaps most readily understand and consider the justest, would be, to fix the premium for a sum assured, bearing interest from the date of last premium to that of the business settlement of the claim. To calculate such a rate, it is obviously only necessary to add a year's interest to the ordinary premium, for

$$\frac{1-i\mathrm{A}}{1+i}\times(1+i)=1-i\mathrm{A},$$

the value required for the single premium, and $\frac{1-i\mathrm{A}}{1+\mathrm{A}}$ for that of the annual rate.

E. J. FARREN.

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[*] This is not unlike the view of the matter taken in a former paper in this Journal. See the note at page 162, vol. ii., where, however, a different expression is arrived at.—Ed. *A. M.*

[†] In France, as in England, it is customary for heirs in such cases to claim $\frac{i}{n}\mathrm{A}$ for current interest from beginning of the year of death. "Dans cette formule nous négligeons pour plus de simplicité, de tenir compte du *pro rata* d'arrérages que pourra être dû par le constituant, au moment du décès du rentier."—*Cournot*, p. 349.